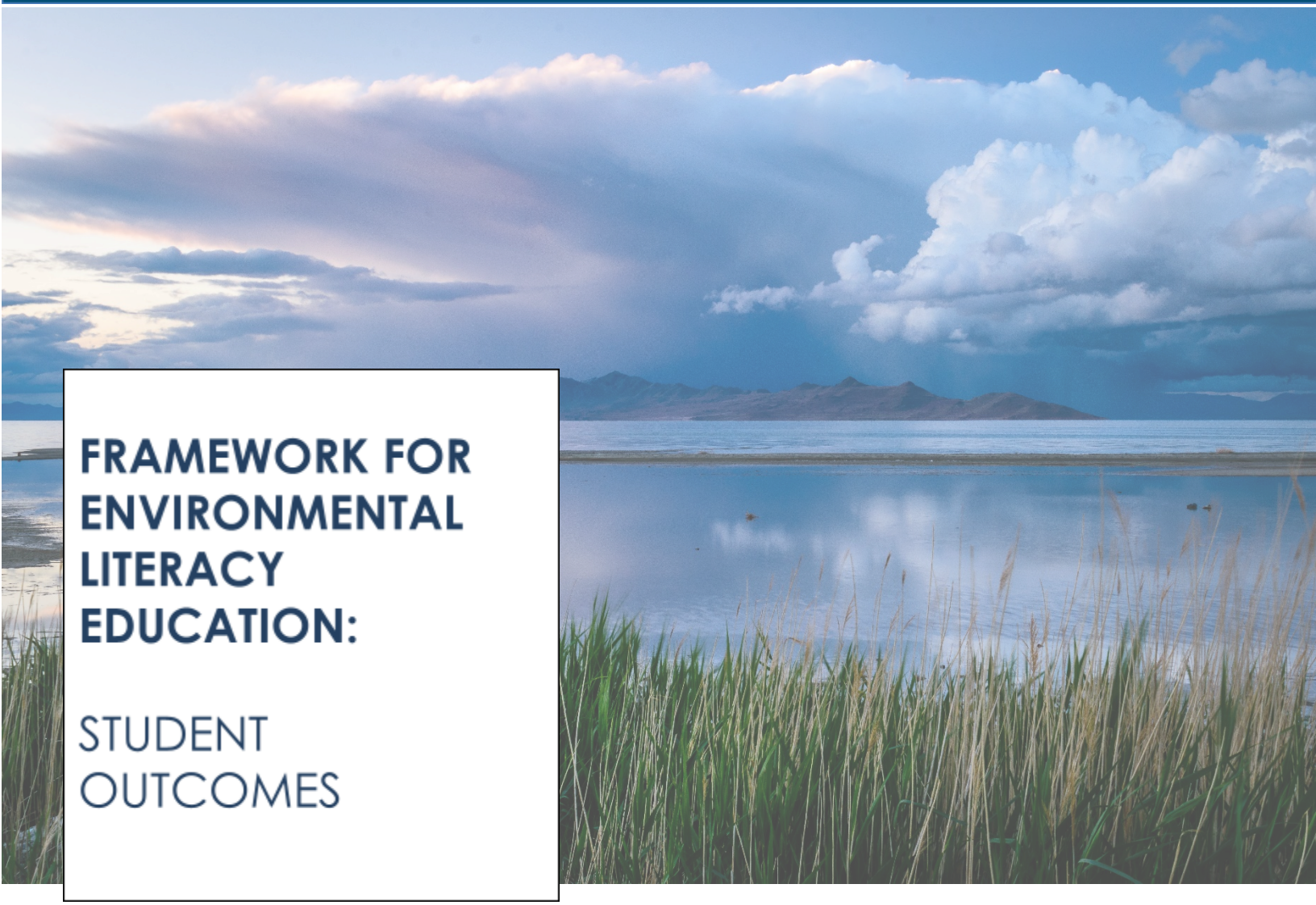

FRAMEWORK FOR ENVIRONMENTAL LITERACY EDUCATION:

STUDENT OUTCOMES

Framework for Environmental Literacy Education: Student Outcomes

Overview

What is the Environmental Literacy Education Framework?

Environmental education (EE) has been a valued focus for educators in a variety of learning contexts for decades. However, despite persistent efforts by EE stakeholders, many school districts have yet to formally integrate EE into formal curriculum at the school system level. For this project, we have explored the ways in which the goals for student learning within EE and formal education cohere and ways in which they might be misaligned. This framework works to unify epistemic perspectives, pedagogical practices, and over-all goals that are prioritized by environmental education stakeholders and those of K-12 education in a set of student outcomes. The ELE Framework of student outcomes is grounded in a conceptualization for environmental literacy education that is informed by a rich history of environmental education in formal and informal spaces and reflects a shared language for student outcomes that may be used to guide the planning, implementation and evaluation of EE activities in formal instructional settings.

Where relevant, the outcomes in this framework have been informed by the language and goals of the Next Generation Science Standards (NGSS) and/or the learning indicators of dimensions of social studies outlined by the College Career and Civic Life Framework (C3) for Social Studies Standards. As such, they are intended to facilitate the articulation of environmental education student outcomes in ways that align with formal academic goals.

This framework was developed with support from the National Oceanic and Atmospheric Administration (NOAA) Bay Watershed Education and Training (B-WET) program and prioritizes the goals of Meaningful Watershed Educational Experiences (MWEEs).

Who Should Use this Framework?

The framework would be appropriate and productive for use by formal and non-formal educators who are endeavoring to develop and implement environmental education programming with K-12 students. It can serve as a guidepost for environmental education providers in both formal and non-formal contexts as they develop their program activities and evaluation plans for students in grades K-12. Users are encouraged to use the outcomes as written, if they seem relevant to their work, or to modify and adapt the outcomes to meet the specific needs of their programs.

The ELE framework provides a comprehensive list of defined student outcomes related to a working definition of environmental literacy that was shaped by work in formal and non-formal fields. The outcomes have been modeled after and aligned with standards-based frameworks for K-12 education including the Next Generation Science Standards (NGSS) and the College, Career, and Civic Life Standards for Social Studies (C3). They have also been informed and shaped by frameworks put forth by professional non-formal education such as Principles for Ocean and Climate Literacies.

Non-Formal Educators

Educators and professions working outside (and/or alongside) formal academic learning contexts may find this framework useful for ensuring that the environmental education programming that they are developing for K-12 students targets not only their goals for environmental knowledge, responsibility, engagement, and 21st Century skills, but that it *also* targets the outcomes of the formal curricular programs in which their programming will be integrated. Environmental education programs that do not purposefully and productively connect to established curricular programs risk being considered by teachers and other participants as being 'extra' or unnecessary. Environmental education programs that include student outcomes that align with academic standards for student achievement utilized by schools may be more likely to be sustained. Furthermore, given that the outcomes in this framework are aligned with formal standards, they are able to *communicate* the value of the environmental education experiences for meeting academic goals.

Formal Educators

Educators and professionals working within formal academic learning contexts may find this framework useful for identifying and articulating the ways that environmental education programming can be legitimately and productively integrated into formal instruction. For example, classroom teachers may wish to integrate field-based learning experiences, which can be particularly productive for learning in that they allow students to apply classroom-based learning in authentic contexts[1], into their instructional programs. This framework could help those educators demonstrate student learning outcomes- related to their curriculum- that are positively impacted by such activities.

Environmental education program designers are encouraged to explore the learning outcomes below and select those that:

- most closely align with the targeted outcomes of planned activities, and/or
- are associated with the academic standards to which the environmental education programming must support.

Designers are encouraged to either use the outcomes as-is or modify as needed in order to ensure that the outcomes meet the unique needs of the environmental education program,

[1] Metz, 2005

Recommendations for Further Additions

This framework currently focuses on outcomes related to knowledge, skills, competencies, dispositions, and practices relevant to science, social studies, stewardship, and general student engagement. We recognize that there are productive opportunities to enhance this framework with the inclusion of areas of focus to further demonstrate the power of environmental literacy education like MWEEs for meeting the dynamic needs of 21st century education. One such area includes culturally responsive pedagogies; social and environmental justice; diversity; equity; and anti-bias education. The *Critical Practices* and *Social Justice Standards* put forth by the Learning for Justice organization (a project of the Southern Poverty Law Center) may be a productive resource for developing relevant student outcomes within environmental literacy education. These resources emphasize learning outcomes specifically related to identify, diversity, justice, and action related to prejudice reduction and collective action. The *Critical Practices* specifically emphasize family and community engagement, which includes Culturally sensitive communication, the inclusion of family and community wisdom, increased connections among families, the use of local resources, and engagement with community issues and problems.

How is the Environmental Literacy Education Framework Structured?

The ELE framework provides a way of thinking about, describing, and planning for environmental literacy education in a way that unites modern perspectives on the importance of active student agency in science with prominent elements of definitions, guidelines, and goals for environmental education that have been used over the last several decades. We operationalize environmental literacy through four primary dimensions that make up environmental literacy:

- **Environmental Knowledge**,
- **Environmentally Responsible Behavior,**
- **Attitudes & Dispositions, and**
- **Environmental Literacy Skills & Disciplinary Practices.**

The next tier of the ELE framework features **categories** that further refine and define each of the four dimensions.

Finally, the framework offers a comprehensive list of observable and measurable **sample student outcomes** related to each dimension, broken down by grade-band where possible, and aligned with formal academic standards.

The ELE framework takes **a holistic approach** to environmental literacy education in which educational programming targets elements of all four dimensions.

The following table provides an overview of the four dimensions of environmental literacy through which the student outcomes are organized. It includes a brief description of each dimension and then lists the categories into which each dimension is broken down.

Table 1: Framework for Environmental Literacy Education Outcomes Overview Chart

Framework for Student Environmental Literacy Education Outcomes

Dimension of Environmental Literacy	Environmental Knowledge	Environmentally Responsible Behavior	Attitudes & Dispositions	Environmental Literacy Skills & Disciplinary Practices
Description	The core ideas relevant to environmental literacy. These outcomes focus on understanding the complex, dynamic nature of life-sustaining systems and human impacts on them.	The competencies, abilities, and actions relevant to making informed decisions and taking action to mitigate the negative impacts of human activities on Earth's systems.	The qualities, habits, views, beliefs, judgements, and ways of thinking that are connected to individuals' abilities to make sense of environmental issues and to take action to preserve and protect earth's systems.	A broad set of knowledge, skills, competencies, traits, and practices related to environmental literacy that are important for success in post-secondary education, careers, and society.
Categories For each category, there are a set of Student Learning Outcomes	◻ Natural Resources ◻ Human Impacts on Earth's Systems ◻ Earth Materials & Systems ◻ Interdependent Relationships in Ecosystems ◻ Cycles of Matter & Energy Transfer in Ecosystems ◻ Ecosystems: Dynamics, Functioning, & Resilience ◻ Biodiversity & Humans ◻ Weather, Climate, & Global Climate Change	◻ Communicating & Critiquing Conclusions ◻ Identifying & Evaluating Solutions ◻ Taking Informed Action	◻ Interest & Curiosity ◻ Personal Impact/Self-awareness ◻ Self-Efficacy ◻ Motivation & Intentions ◻ Sensitivity	**Skills:** ◻ Critical Thinking ◻ Communication ◻ Creativity ◻ Collaboration ◻ Problem-Solving **Practices:** ◻ Asking Questions & Defining Problems ◻ Developing & Using Models ◻ Planning & Carrying out investigations ◻ Analyzing & Interpreting Data ◻ Constructing Explanations & Designing Solutions ◻ Engaging in Argument from Evidence

In the sections that follow, you will find more information about each dimension and its categories. You will also find series of tables that articulate concepts of environmental literacy by grade band related to each category of the dimensions. These grade-appropriate concepts are derived from a broad array of research studies in both science education and environmental education.

Dimension: Environmental Knowledge

In this framework, environmental knowledge refers to a set of **core ideas** that outline the knowledge and conceptual understanding required for environmental literacy. Knowledge is a critical tool for understanding and investigating environmental and sustainability issues as well as providing a foundation for decision-making and problem-solving. As a dimension of environmental literacy in this framework, **Environmental Knowledge** represents the *cognitive* elements of environmental literacy.

Environmental knowledge is presented here as progressing developmentally across grade bands. The six areas of focus detailed below reflect the goals and priorities articulated by stakeholders and educators in environmental fields. They are not exhaustive. Many environmental education activities support understanding in more than one of these content areas.

The language of the **Environmental Knowledge** dimension has been informed by and modeled after the ways that these ideas are articulated in the framework for K-12 Science Education, the Next Generation Science Standards, and the College Career and Civic Life Framework for Social Studies Standards. These formal frameworks prioritize active sensemaking of conceptual ideas over the restatement of isolated facts. Thus, rather than noting that students will simply "know," "recognize," or "understand" facts or definitions these frameworks communicate learning outcomes in ways that require active understandings of core ideas through practice. To mirror this approach to articulating student outcomes, the **Environmental Knowledge** dimension of this ELE framework presents core ideas related to categories of environmental knowledge (as opposed to discrete facts) with language that encourages EE program designers to develop outcomes that allow opportunities for students to express their understanding of these ideas through participation in authentic disciplinary practices. To facilitate this, the following statement precedes the core ideas of each category:

> *"Students will construct and demonstrate knowledge related to one or more of the following ideas"*

Examples of demonstrating understanding through practice can include developing and/or using models to represent phenomena and communicate understandings, using evidence developed through EE experiences to construct explanations for phenomena, or evaluating the relative strength of data as evidence to support given claims.

Environmental Knowledge Student Outcomes

Dimension: Environmental Knowledge
Category: Natural Resources
Standards Alignment: NGSS: ESS3.A
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
◻ Living things need resources from the environment and live in places that have what they need. ◻ Humans use natural resources for everything they do.	◻ Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. ◻ Some resources are renewable over time, and others are not. ◻ Human uses of natural resources affect ecosystems (including watershed ecosystems) in multiple ways.	◻ Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. ◻ Natural resources are limited, and many are not renewable or replaceable over human lifetimes. ◻ Human uses of natural resources affect ecosystems (including watershed ecosystems) in multiple ways.	◻ Resource availability has guided the development of human society. ◻ All forms of energy production and resource extraction have associated costs and risks as well as benefits. Regulations and technologies can impact the effects of energy production and resource extraction.

Dimension: Environmental Knowledge
Category: Human Impacts on Ecosystems
Standards Alignment: C3: D2. Geo.8; NGSS: ESS3.A, ESS3.C
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
◻ People use resources from the environment to meet their needs and wants. ◻ Our choices and activities affect the cultural and environmental characteristics of ecosystems (including watershed ecosystems) and impact living and nonliving things.	◻ Human activities in agriculture, industry, and everyday life have major effects on ecosystems.	◻ Human activities have significantly altered Earth's ecosystems, which are all connected in the biosphere. ◻ Cultural patterns and economic decisions influence environments and the daily lives of people.	◻ Relationships and interactions within and between human systems and Earth's systems contribute to reciprocal influences that occur among them. ◻ The sustainability of human societies & biodiversity that supports them requires responsible resource management.

◻ But they can make choices that reduce their impacts on the land, water, air, and other living things.		◻ There are connections between population increases, per-capita consumption, & human impacts on Earth's ecosystems (including watershed ecosystems).	◻ Science, engineering, and technology play important roles in environmental protection.

Dimension: Environmental Knowledge
Category: Earth's Materials & Systems
Standards Alignment: NGSS ESS2.A; NOAA Ocean Literacy Principles 1, 2, 3, 4, 5, 6; Climate Literacy Principles 1, 2, 4, 6
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
◻ Wind and water can change the shape of the land. ◻ Things that happen on land can affect water on Earth and the plants and animals that live there. ◻ The Earth has one big ocean with many features.	◻ Earth is a complex system of interacting subsystems. ◻ The major subsystems of Earth are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). ◻ The ocean is the largest part of the hydrosphere and is connected to major lakes, watersheds, and waterways because all major watersheds on Earth drain to the ocean. ◻ Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller	◻ All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. ◻ The energy that flows within and among Earth's systems is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. ◻ The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. ◻ Interactions between Earth's systems have shaped Earth's history and will determine its future.	◻ Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. ◻ The geologic record shows that changes to global and regional climate can be caused by many factors, including human activities. ◻ The ocean moderates the Earth's climate, influences our weather, and affects human health. ◻ The ocean provides food, medicines, and mineral and energy resources. It supports jobs and national economies, serves as a highway for transportation of goods and people, and plays a role in national security.

	particles and move them around. ▫ Rivers and streams transport nutrients, salts, sediments, and pollutants from watersheds to coastal estuaries and to the ocean. ▫ The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate.	▫ The ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for life to exist on Earth.	

Dimension: Environmental Knowledge
Category: Interdependent Relationships in Ecosystems
Standards Alignment: NGSS: LS2.A
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
▫ Plants and animals need food, water, shelter, and light to grow.	▫ Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms, eventually restoring some materials back to the soil. ▫ Organisms can survive only in environments in which their needs are met. ▫ A healthy ecosystem is one in which multiple species of different types are each able	▫ Organisms and populations of organisms in ecosystems are dependent on interactions with other living and nonliving things. ▫ In any ecosystem (including watershed ecosystems) organisms and populations may compete for limited resources. ▫ Growth of organisms and population increases are limited by access to resources.	▫ Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations that the ecosystem can support. ▫ Carrying capacity limits within ecosystems result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.

	to meet their needs in a relatively stable web of life. ▫ Newly introduced species can damage the balance of an ecosystem.		

Dimension: Environmental Knowledge
Category: Cycles of Matter and Energy Transfer in Ecosystems
Standards Alignment: NGSS: LS2.B
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
▫ Plants and animals need food, water, shelter, and light to grow.	▫ Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. ▫ Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	▫ Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. ▫ In any ecosystem (including watershed ecosystems) organisms and populations may compete for limited resources. ▫ Growth of organisms and population increases are limited by access to resources.	▫ Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. ▫ Plants or algae form the lowest level of the food web. Only a small amount of the matter consumed at each level of the food web is transferred up to the next level. Therefore, there are generally fewer organisms at higher levels of a food web. At each link in an ecosystem, matter and energy are conserved.

Dimension: Environmental Knowledge
Category: Dynamics, Functioning, & Resilience of Ecosystems
Standards Alignment: NGSS: LS2.C
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
☐ Changes to an environment can affect the plants	▫ When the environment changes in ways that affect a place's physical characteristics, some organisms survive and	▫ The characteristics of ecosystems can change over time. Disruptions to any physical or biological component of an	▫ A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long

and animals that live there	reproduce, some move to new locations, some move into the transformed environment, and some die.	ecosystem can lead to shifts in populations of living things. ▫ Biodiversity describes the variety of species found in ecosystems. An ecosystem's biodiversity is often used as a measure of its health.	periods of time under stable conditions. ▫ Extreme changes in conditions (including the size of any population of living things) can affect the functioning of ecosystems in terms of resources and habitat availability. ▫ Anthropogenic changes (induced by human activity) to the environment can disrupt an ecosystem.

Dimension: <u>Environmental Knowledge</u>
Category: Biodiversity and Humans
Standards Alignment: NGSS: LS2.D
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
▫ There are many different kinds of living things in any area (including watersheds). ▫ Living things are found in different places on land and in water.	▫ Populations live in a variety of habitats (including those within a watershed) and changes to those habitats affects the organisms living there.	▫ Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on.	▫ Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). ▫ Humans depend on Earth's systems for the resources and other benefits provided by biodiversity. But human activity is also having negative impacts on biodiversity. ▫ Sustaining biodiversity to maintain the functioning and productivity of ecosystems (including watershed ecosystems) is essential to supporting and enhancing life on Earth.

Dimension: Environmental Knowledge
Category: Weather, Climate, & Global Climate Change
Standards Alignment: NGSS ESS2.D; NGSS ESS3.D; Climate Literacy Principles 2, 4, 5, 6
Outcome: *Students will engage in 21st Century skills and disciplinary practice(s) to construct and demonstrate knowledge related to the idea that:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
◻ Sunlight can heat the land, ocean, and air on Earth. ◻ Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. ◻ People measure these conditions to describe and record the weather and to notice patterns over time.	◻ Weather is not the same thing as climate. Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. ◻ Climate is not the same thing as weather. Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. ◻ Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	◻ Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. ◻ The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. ◻ Human activities are major factors in the current rise in Earth's mean surface temperature (global warming), which in turn has negative effects on Earth's life-sustaining systems (including watershed ecosystems). ◻ Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of	◻ Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. ◻ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. ◻ Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. ◻ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. ◻ Our understanding of the climate system is improved through observations, theoretical studies, and modeling. ◻ Important discoveries are still being made about how the ocean, the

		climate science, engineering capabilities, and other kinds of knowledge.	atmosphere, and the biosphere interact and are modified in response to human activities.

Environmentally Responsible Behavior

Environmentally responsible behavior refers to the active and outward expression of environmental literacy. It is sometimes referred to as "pro-environmental behavior," "environmentally significant behavior," "stewardship" and other terms. Here, environmentally responsible behaviors are defined as intentional and habitual actions intended to and that have a positive impact on the environment. The dimension of **Environmentally Responsible Behavior** is presented in terms of three categories: ***Communicating and Critiquing Conclusions***, under which students formalize arguments, explanations, perspectives, and claims in support or protection of the environment; ***Identifying & Evaluating Solutions***, in which students identify and explore solutions to environmental issues or problems; and ***Taking Informed Action***, in which students participate in activities or projects that support or protect the environment--through which students adapt and apply their understandings and points of view in active ways.

The three categories of **Environmentally Responsible Behavior** have been articulated through grade-band outcomes. This is because there are clear connections between these goals and student learning outcomes within formal frameworks for standards-based, K-12 education, which provide guidance for how such goals are approached across a student's K-12 experience (and beyond).

Environmentally Responsible Behavior Student Outcomes

Dimension: Environmentally Responsible Behaviors
Category: Communicating & Critiquing Conclusions
Standards Alignment: C3: D4; NGSS: ESS3.A, C; NGSS: ETS1.A, B, C
Outcome: *Students will engage in and demonstrate environmentally responsible behavior as they:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
▫ Make and explain an argument about the importance of the responsible management of natural resources.	▫ Use evidence from the MWEE/environmental education program to construct and communicate an idea and/or argument about	Use evidence from the MWEE/environmental education program to construct, communicate, and critique claims about the *importance* of	▫ Construct, communicate, and critique claims (acknowledging strengths and limitations of the claims) about the importance of responsible management of

◻ Make and explain an argument about the importance of taking care of the environment.	the *importance of* minimizing the negative impacts of human activities on the environment. ◻ Use evidence from the MWEE/environmental education program to construct and communicate a claim about the *relevance of* responsible management of natural resources on the student's life and the lives of others. ◻ Use evidence from the MWEE/environmental education program to construct and communicate an idea and/or argument about the *importance of* minimizing the negative impacts of human activities on the environment.	responsible management of natural resources **OR** about the *importance of* environmental protection. ◻ Use evidence from the MWEE/environmental education program to construct, communicate, and critique claims about the *relevance* of responsible management of natural resources or environmental protection to our lives. ◻ Evaluate the merits of solutions designed to respond to problems or issues related to the responsible management of natural resources **OR** environmental protection. ◻ Present adaptations of arguments and explanations about responsible management of natural resources **OR** related environmental protection on the environment to others to reach audiences and venues outside the classroom.	natural resources **OR** related to environmental protection using precise, informed evidence. ◻ Construct, communicate, and critique claims (acknowledging strengths and limitations of the claims) about the relevance of responsible management of natural resources **OR** environmental protection on the student's life and the lives of others using precise, informed evidence. ◻ Evaluate solutions to problems related to the responsible management of natural resources **OR** related to minimizing the environmental protection based on prioritized criteria and trade-offs that account for a range of constraints. ◻ Present adaptations of arguments and explanations about responsible management of natural resources **OR** related to environmental protection to others to reach audiences and venues outside the classroom.

Dimension: Environmentally Responsible Behaviors
Category: Identifying & Evaluating Solutions
Standards Alignment: ETS1-1, 1-2, 1-3
Outcome: *Students will engage in and demonstrate environmentally responsible behavior as they:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
◻ Ask questions, make observations, and gather	◻ Identify and/or describe multiple solutions to an	◻ Define the criteria and constraints of an	◻ Analyze environmental problems or challenges to

information about a situation people want to change to define a simple problem. □ Identify and/or describe a solution to an environmental problem, issue, or challenge. □ Explain why a given solution may work well to address an environmental problem, issue, or challenge. □ Explain why a given solution may ***not*** work well to address an environmental problem, issue, or challenge.	environmental problem, issue, or challenge. □ Identify criteria for a successful solution and constraints for implementing solution(s). □ Explain why a given solution may work well to address an environmental problem, issue, or challenge. □ Explain why a given solution may ***not*** work well to address an environmental problem, issue, or challenge.	environmental problem, issue, or challenge with sufficient precision to identify and describe a successful solution. □ Identify and describe scientific ideas and information that are relevant to solutions. □ Identify and describe the potential intended and unintended impacts of a solution on people and the natural environment. □ Use evidence to explain the merits and limitations of a given solution to an environmental problem, issue, or challenge. □ Systematically evaluate competing solutions for an environmental problem according to identified criteria and constraints.	specify qualitative and quantitative criteria and constraints for solutions. □ Identify and describe scientific ideas and information that are relevant to solutions. □ Identify and describe the potential intended and unintended impacts of a solution on people and the natural environment. □ Use evidence to explain the merits and limitations of a given solution to an environmental problem, issue, or challenge. □ Design a solution to a complex environmental problem by breaking it down into smaller, more manageable problems. □ Evaluate a solution to a complex environmental problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Dimension: Environmentally Responsible Behaviors
Category: Taking Informed Action
Standards Alignment: C3: D4.6, D4.7, D4.8; ● NGSS: ESS3.A, C, ETS1.A, B, C
Outcome: *Students will engage in and demonstrate environmentally responsible behavior as they:*

Primary Grades (k-2)	Elementary Grades (3-5)	Middle Grades (6-8)	High Grades (9-12)
□ Identify and explain some ways in which people are trying to address problems	□ Explain different strategies and approaches students and others could take to	□ Assess their individual and collective capacities to take action to address	□ Use disciplinary and interdisciplinary lenses to understand the

related to the responsible management of natural resources. □ Identify ways that the student could (individually or collectively) take action to help address problems related to the responsible management of natural resources. □ Work collaboratively to plan and take action to respond to problems related to the responsible management of natural resources in their communities and/or local watersheds.	address problems related to resource management and predict possible challenges to and results of their actions. □ Work collaboratively to decide on, plan, and take action (including civic action) to respond to problems related to the responsible management of natural resources or environmental protection in their communities and/or local watersheds. □ Evaluate the success of their actions based on defined criteria. □ Develop plans to monitor and/or sustain the positive impacts of their actions on their communities and/or local watersheds.	local, regional, and global problems. □ Work collaboratively to decide on, plan, and take action to respond to problems related to the responsible management of natural resources in their communities and/or local watersheds. □ Evaluate the success of their actions based on defined criteria. □ Develop and implement plans to monitor and/or sustain the positive impacts of their actions on their communities and/or local watersheds.	characteristics and causes of local, regional, and global problems; instances of such problems in multiple contexts; and challenges and opportunities faced by those trying to address these problems over time and place. □ Assess options for individual and collective action to address local, regional, and global problems by engaging in self-reflection, strategy identification, and complex causal reasoning. □ Apply a range of deliberative and democratic strategies and procedures to make decisions and take action to respond to problems related to the responsible management of natural resources in their communities and/or local watersheds. □ Evaluate the success of their actions based on defined criteria. □ Develop and implement plans to monitor and/or sustain the positive impacts of their actions on their communities and/or local watersheds.

Attitudes & Dispositions

In the context of environmental education, the constructs of "attitudes" and "dispositions" are often viewed as being productive for enhancing and sustaining environmental literacy and environmental stewardship. The **Attitudes and Dispositions** dimension of this framework describes some of the affinities, inclinations, sentiments, orientations, and proclivities many

environmental education researchers consider essential to the actions of that are associated with environmentally responsible individuals. When these characteristics are exhibited by students in ways that link to positive environmental outcomes, it can indicate a view of the environment that is in line with the goals of environmental literacy education. This list is not exhaustive and environmental education activities are likely to result in a variety of interconnected demonstrations of student attitudes and dispositions, many of which may overlap with each other as well as with demonstrations of other dimensions of environmental literacy.

The outcomes within **Attitudes & Dispositions** have not been articulated in grade-level specific progressions because they are expressed in varying ways by individuals of all ages. It may be valuable for future efforts in this field to attempt to determine goals for how each of these attitudes and dispositions should manifest across grade levels, however that is not part of the scope of this current project.

Attitudes & Dispositions: Student Outcomes

Dimension: Attitudes & Dispositions **Category:** Motivation & Intentions **Outcome:** *Students will display and/or demonstrate characteristics related to motivation & intentions by:*	**Dimension:** Attitudes & Dispositions **Category:** Attention **Outcome:** *Students will display and/or demonstrate characteristics related to attention by:*
All grade levels	***All grade levels***

- willingness to participate in learning activities
- desire to succeed at learning tasks
- interest in learning more
- willingness to take further action

- concentration and focus on tasks
- careful listening and/or watching
- complying with directions and requests

Dimension: Attitudes & Dispositions
Category: Interest & Curiosity
Outcome: *Students will display and/or demonstrate characteristics related to interest & curiosity by:*

All grade levels

- asking questions
- testing and/or applying new ideas
- inquisitiveness
- desire to learn more
- interest in taking further action

Dimension: Attitudes & Dispositions
Category: Optimism
Outcome: *Students will display and/or demonstrate characteristics related to optimism by:*

All grade levels

- hopefulness about outcomes of activities and/or about progress toward reaching goals
- confidence in the potential success of activities
- dispositions or tendencies to identify favorable elements of activities and actions
- expectations for positive outcomes

Dimension: Attitudes & Dispositions
Category: Personal Impact & Self-awareness
Outcome: *Students will display and/or demonstrate characteristics related to personal impact & self-awareness by:*

All grade levels

- understanding of the impact of individual and collective choices on the health of

Dimension: Attitudes & Dispositions
Category: Self-efficacy
Outcome: *Students will display and/or demonstrate characteristics related to self-efficacy by:*

All grade levels

- understanding of and belief in one's own ability to achieve goals, influence others,

the environment (including local watersheds)

affect change (individually and collectively)

Dimension: Attitudes & Dispositions **Category:** Sensitivity **Outcome:** *Students will display and/or demonstrate characteristics related to*
All grade levels
▫ concern for the environment ▫ caring and positive feelings toward the environment

Environmental Literacy Skills & Disciplinary Practices

The 21st century will continue to pose new demands on people to adapt their capabilities in an ever-changing landscape of challenges to the workforce, self-actualization, and global sustainability. Escalating impacts of human activities on Earth's life-sustaining systems demand that we prepare our students to be able to employ particular skills (such as critical thinking and problem-solving) and engage in authentic, productive practices associated with science and, specifically, environmental science (like interpreting models and analyzing data) in order to respond to and mitigate 21st century challenges. Competencies within these skills and practices

are important for environmental literacy and schools serve an important role in helping students develop, apply, and strengthen them.

There are many ways to conceptualize and define the skills and practices that are associated with and productive for environmental literacy. Many environmental education programs employ and advance a wide range of these types of skills, which are often grouped under a "21st century" heading. The skills and practices featured here are often evoked within environmental education contexts and are commonly identified as being essential for modern K-12 education. In other words, competencies within these skills and practices are important for environmental literacy and schools serve an important role in helping students develop, apply, and strengthen them.

Environmental Literacy Skills: Many environmental education programs employ and advance a wide range of the **skills** included in this dimension. They are often grouped under a "21st century" heading. These skills manifest and are leveraged, in a variety of ways
Disciplinary Practices: Many of the practices listed as subcategories within this dimension are featured in and promoted by the Next Generation Science Standards. They have been adapted here to reflect relevance to environmental education programs and environmental literacy education.

The behaviors listed for each environmental literacy skill and disciplinary practice are not presented here as being grade-band specific, although there are progressive degrees of appropriate engagement and application of these skills and practices across grade levels. The characteristics of each skill and practice identified in the student outcomes tier are merely examples of the ways that students might demonstrate these capabilities. It is important to note that a student does not need to be observed demonstrating every single characteristic in the list in order to engage in a particular skill or practice. Furthermore, a student may exhibit behaviors that seem to reflect characteristics of more than one skill or practice. The behaviors here are not exhaustive and it is recommended that environmental education programmers consult the NGSS and C3 for more detailed descriptions of the practices, including grade-band progressions.

Environmental Literacy Skills & Disciplinary Practices: Student Outcomes

Dimension: Environmental Literacy Skills **Category:** Critical Thinking **Outcome:** *Students will display and/or engage in critical thinking by:*
All grade levels
◻ Explaining an issue or problem ◻ Identifying and using evidence effectively ◻ Analyzing contexts

Dimension: Environmental Literacy Skills **Category:** Communication **Outcome:** *Students will display and/or engage in communication by:*
All grade levels
◻ Thinking 'outside of the box' ◻ Applying and synthesizing multiple perspectives

- Describing your own perspectives and those of others
- Drawing logical conclusions
- Making informed decisions
- Evaluating the success of solutions according to given criteria
- Determine the merit of claims based on available evidence
- Identify and understand biases

- Expressing ideas and information in a variety of ways
- Breaking and making connections between ideas, assumptions, situations
- Developing and sharing new ideas

Dimension: Environmental Literacy Skills
Category: Creativity
Outcome: *Students will display and/or engage in creativity by:*

All grade levels

- Thinking 'outside of the box'
- Applying and synthesizing multiple perspectives
- Expressing ideas and information in a variety of ways
- Breaking and making connections between ideas, assumptions, situations
- Developing and sharing new ideas

Dimension: Environmental Literacy Skills
Category: Collaboration
Outcome: *Students will display and/or engage in collaboration by:*

All grade levels

- Working with others to identify and solve problems
- Demonstrating flexibility
- Motivating, supporting, and inspiring others
- Listening to other points of view
- Integrating ideas from team members
- Demonstrating accountability
- Setting, working toward, and achieving goals as a team

Dimension: Environmental Literacy Skills
Category: Problem-Solving
Outcome: *Students will display and/or engage in problem-solving by:*

All grade levels

- Clearly defining and redefining a problem
- Demonstrating a systematic approach to seeking solutions
- Researching relevant information
- Managing Risks
- Making Decisions

- Generating options
- Determining and evaluating constraints and criteria for success
- Evaluating the merits of solutions
- Implementing solutions

Dimension: Disciplinary Practices
Category: Analyzing & Interpreting Data
Outcome: *Students will display and/or engage in analyzing & interpreting data by:*

All grade levels

- Record information (observations, thoughts, and ideas).
- Use and share pictures, drawings, and/or writings of observations.
- Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
- Compare predictions (based on prior experiences) to what occurred (observable events).
- Construct, analyze, and/or interpret graphical displays of data to reveal patterns that indicate relationships.
- Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
- Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
- Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
- Use data to evaluate and refine design solutions.

Dimension: Disciplinary Practices
Category: Planning & Carrying Out Investigations
Outcome: *Students will display and/or engage in planning & carrying out investigations by:*

All grade levels

- Collaboratively plan and conduct an investigation to produce data to serve as the basis for evidence to answer a question.
- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
- Make observations (firsthand or from media) to collect data that can be used to make comparisons.
- Make predictions based on prior experiences.
- Select appropriate tools to collect, record, analyze, and evaluate data.
- Evaluate the accuracy of various methods for collecting data.
- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Dimension: Disciplinary Practices
Category: Engaging in Argument from Evidence
Outcome: *Students will display and/or engage in argument from evidence by:*

All grade levels

- Identify and construct arguments that are supported by evidence.
- Distinguish between explanations that account for all gathered evidence and those that do not.
- Analyze why some evidence is relevant to a scientific question and some is not.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- Distinguish between opinions and evidence in one's own explanations.
- Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.
- Construct an argument with evidence to support a claim.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

Dimension: Disciplinary Practices
Category: Constructing Explanations & Designing Solutions
Outcome: *Students will display and/or engage in constructing explanations & designing solutions by:*

All grade levels

- Record information (observations, thoughts, and ideas).
- Use information from observations (firsthand and from media) to construct an evidence-based account for natural and/or human-driven phenomena.
- Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
- Generate and/or compare multiple solutions to a problem.
- Construct an explanation of observed relationships
- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation.
- Apply scientific ideas to solve problems.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the solution.

Dimension: Disciplinary Practices
Category: Developing & Using Models
Outcome: *Students will display and/or engage in developing & using models by:*

All grade levels

Dimension: Disciplinary Practices
Category: Asking Questions & Defining Problems
Outcome: *Students will display and/or engage in asking questions & defining problems by:*

All grade levels

- Develop and use models based on evidence to represent an object, tool, process, phenomenon, and/or event.
- Distinguish between the model and the actual object, tool, process, phenomenon, and/or event that the model represents.
- Identify limitations of models.
- Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed.
- Develop and/or use a model to predict and/or describe phenomena.
- Develop a model to describe unobservable mechanisms.

- Ask questions based on observations to find more information about the natural and/or designed world(s).
- Ask questions for clarification, to refine ideas or models, and/or to seek new information.
- Ask and/or identify questions that can be answered through investigations.
- Define and describe problems that warrant investigation and/or solution-seeking.

Summary & A Vision for the Future

At this stage, the ELE Framework would be appropriate and productive for use by formal and informal educators who endeavor to develop and implement environmental education programming with K-12 students. Users are encouraged to use the outcomes as written, if they seem relevant to their work, or to modify and adapt the outcomes to meet the specific needs of their programs. Educators and professionals working within formal academic learning contexts may find the ELE framework useful for identifying and articulating the ways that environmental education programming can be legitimately and productively integrated into formal instruction. Non-formal EE providers can use the outcomes within the ELE framework to increase the likelihood that the ways they are approaching the design and subsequent evaluation of their programming will seem to "match" and fit into formal programs, thus communicating the value of the EE experiences for meeting academic goals through a "language" utilized by schools.

Appendix A

How to Use This Framework

This framework promotes a holistic approach to environmental literacy education in which education programming targets elements of all four dimension. Stakeholders (including program designers and/or evaluators) looking to use the ELE framework to help design and/ or evaluate a MWEE or other environmental education program might first begin by deciding what it is that they want students to understand and be able to do better as a result of participating in the program. The next step is to work down the tiers of the framework, deciding which categories of each dimension and which student outcomes best meet the goals of the program. Finally, stakeholders should make any appropriate "tweaks" or edits to make sure the outcomes are a productive fit.

The following represents an example set of student outcomes for a MWEE that were developed using the ELE framework.

Example: Using the ELE framework to articulate student environmental literacy outcomes for a MWEE (5th grade)

MWEE FOCUS: The importance of healthy ecosystems and how we can take action to protect our local watershed		
Dimension of Environmental Literacy	Targeted Categories	Student Outcomes *Students will:*
Environmental Knowledge	▪ Ecosystems: Dynamics, Functioning, & Resilience ▪ Human Impacts on Earth's Systems	1. Construct and demonstrate knowledge related to the idea that when the environment changes in ways that affect a place's physical characteristics, some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. 2. Construct and demonstrate knowledge related to the idea that human activities in agriculture, industry, and everyday life have major effects on ecosystems
Environmentally Responsible Behavior	▪ Communicating & Critiquing Conclusions ▪ Identifying & Evaluating Solutions ▪ Taking Informed Action	3. Use evidence from the EE to construct and communicate an idea and/or argument about the importance of minimizing the negative impacts of human activities on the environment. 4. Identify and/or describe multiple solutions to an environmental problem, issue, or challenge. 5. Work collaboratively to decide on, plan, and take action (including civic action) to respond to problems related to the responsible management of natural resources or environmental protection in their communities and/or local watersheds. 6. Evaluate the success of their actions based on defined criteria. 7. Develop plans to monitor and/or sustain the positive impacts of their actions on their communities and/or local watersheds.
Attitudes & Dispositions	▪ Self-Efficacy ▪ Sensitivity ▪ Personal Impact & Self-Awareness	8. *Display and/or demonstrate* understanding of and belief in one's own ability to achieve goals, influence others, affect change (individually and collectively) 9. *Display and/or demonstrate* understanding of the impact of individual and collective choices on the health of the environment (including local watersheds) 10. *Display and/or demonstrate* caring and positive feelings toward the environment
Environmental Literacy Skills & Disciplinary Practices	**Skills:** ▪ Collaboration ▪ Problem-Solving **Practices:** ▪ Analyzing & Interpreting Data, ▪ Developing & Using Models	11. Work with others to identify and solve problems 12. Define a problem, research information related to solutions, evaluate the merits of a solution, and implement a solution. 13. Analyze and interpret data to make sense of phenomena, using logical reasoning. 14. Use information from observations (firsthand and from media) to construct an evidence-based account for natural and/or human-driven phenomena. 15. Develop and use models based on evidence to represent an object, tool, process, phenomenon, and/or event.

	Constructing Explanations & Designing Solutions	

Appendix B

Why Environmental Literacy?

Environmental *education* often serves as a catchall term and is sometimes used synonymously with outdoor education. The term environmental education can mean activities, pedagogical approaches, and/or outcomes. The ELE framework focuses specifically on **environmental literacy** as a *goal* of environmental education. It was developed as a series of environmental literacy outcomes that could be achieved through Meaningful Watershed Educational Experiences (MWEEs), a unique approach to environmental education programming that utilizes elements of project-based learning with both in-classroom and outdoor learning experiences. MWEEs engage students in active investigations into local environmental issues and culminate in students taking action to address the problems they identified and explored.

The environmental literacy outcomes in this framework could also be effectively achieved through a variety of types of environmental education programing and pedagogies (e.g. place-based learning) that utilize any of a variety of instructional strategies including outdoor field experiences, in-classroom work, stewardship activities, laboratory exercises, online simulations, and more.

The focus on environmental *literacy* is also important for alignment with formal academic goals. Developing and advancing literacies is widely considered a top responsibility of schooling and the outcomes within the ELE framework have been developed to align specifically with established standards and indicators of student achievement in formal contexts.

Appendix C

More About MWEES

Meaningful Watershed Educational Experiences (MWEEs) represent one approach to environmental literacy education. MWEEs seek to increase understanding and stewardship of watersheds and related ocean, coastal, riverine, and estuarine ecosystems through learner-centered investigations of local environmental issues. Students use the understandings they have developed in their investigations to plan and implement informed stewardship actions that address these issues.

In many regions, systemic integration is a programmatic goal of MWEEs. The intention is that entire populations of students in targeted grade levels or courses all have equal access to participation. Through integration, MWEEs are not merely *added to* programs as additional or 'extra' lessons or units, they *are part of* the standard curriculum that all teachers provide for all students. The MWEE thus becomes the pedagogical approach and content focus for supporting

students to meet the academic standards and/or learning objectives for the curricular unit. The success of systemic MWEEs depends on support from multiple community stakeholders including district-level curriculum supervisors, administrators, and teachers. They also often benefit from the support of community partners including non-formal education providers, state departments of natural resources, and more. In order to establish and maintain support, MWEE programs must be able to clearly and adequately demonstrate their value for supporting school goals.

As noted above, student outcomes for environmental education experiences like MWEEs that align with standards for student achievement utilized by school systems can be a productive way to evaluate and communicate the impact of those experiences in ways that increase the buy-in and thus sustainable implementation of target school audiences.

The student outcomes in this framework are organized into four major categories or dimensions, which align with outcomes articulated by environmental education stakeholders. They have been informed by discussions with the NOAA B-WET program managers; research and scholarship in social studies education, science education, environmental education, principles for climate, oceanic, geographic literacy; and other related professional fields.

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